Republic of Kenya

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KS 77 (2012) (English): Protective helmets for motorcyclists — Specification (Draft Standard)

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DRAFT KENYA STANDARD **DKS 77: 2012**

ICS

Protective helmets for motorcyclists — Specification

DRAFT KENYA STANDARD, APRIL 2012

 Second Edition 2012

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Consumer Information Network (C.I.N)
General Motors (East Africa) Ltd.
Kenya Auto Bazaar Association (K.A.B.A)
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Kenya Used Motor Parts Importers Association (K.U.M.P.I.A)
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Ministry of Roads – Mechanical & Transport Department
Motor Vehicle Inspection Unit
Mutsimoto Motor Co. Ltd.
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Kenya Bureau of Standards — Secretariat

REVISION OF KENYA STANDARDS

In order to keep abreast of progress in industry, Kenya Standards shall be regularly reviewed. Suggestions for improvements to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome.

DRAFT KENYA STANDARD

DKS 77: 2012
ICS

Protective helmets for motorcyclists — Specification

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Foreword

This Kenya Standard was prepared by the Road Vehicles Technical Committee under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

Experience has shown that the effects of an impact can be considerably mitigated, within the limitations stated, because an effective proportion of the energy of the impact is absorbed by a helmet: The force of the blow which is transmitted to the head of the wearer is thereby reduced. However, it should be appreciated that the protection given by a helmet cannot be absolute regardless of the circumstances and the severity of an accident and that the use of a helmet cannot always prevent death or long-term disability following a severe accident. Whilst absorbing energy the structure of the helmet may be damaged and any helmet which sustains a severe blow shall be replaced by a new helmet even if damage is not apparent.

Competition helmets are built to more stringent requirements of other standards and some motorcyclists may prefer the extra protection these offers even for everyday use.

This standard gives methods of test for the fundamental performance requirements and the minimum results required from a satisfactory helmet. It sets out the general principles of design whilst leaving the manufacturer as much freedom as possible in respect of the materials used, the actual design and the methods employed to provide the required levels of protection. A helmet shall be as light in weight as possible both for the comfort of the wearer and to limit certain effects in the event of an accident and it is also very important that the helmet is a good fit.

This standard has been revised to address the increased failures during the use of helmets and the prevalent non use of the helmets due to various factors such as discomfort, health concerns among others as well as technological changes.

This second edition cancels and replaces the 1978 edition.

The revision of this standard has been facilitated by World Health Organization (WHO) – Kenya under the Road Safety 10 (RS10) project funded by Bloomberg Philanthropies.

In the preparation of this standard, reference was made to the following documents:

UNECE R 22 Rev.4, Uniform provisions concerning the approval of protective helmets and their visors for drivers and passengers of motor cycles and mopeds

Global Helmet Vaccine Initiative (GHVI), Draft Standard Version 1.1, 14 November 2010, Draft specification for protective helmets for motorcyclists

IS 4151, Indian Standard, protective helmets for scooter and motorcycle riders

Acknowledgement is hereby made for the assistance derived from these sources.

Protective helmets for motorcyclists — Specification

1 Scope

This Kenya Standard specifies the requirements for protective helmets intended for the protection of the driver or of the rider and the pillion (passenger) while riding motorcycles of any kind, including motorized bicycles/tricycles, mopeds, motorbikes, quad bikes and scooters with or without side-car.

The standard does not apply to protective helmets intended to be used for competition riding.

2 Normative references

The following referenced documents are indispensable for the application of this Kenya Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 960, *Headforms for use in the testing of protective helmets*

ISO 6487, *Road vehicles - Techniques of measurement in impact tests - Instrumentation*

3 Definitions

For the purposes of this Standard the following definitions shall apply:

2.1
motorcycle
include motor bike, motorized bicycle/tricycles, moped, scooters, quad bikes.

2.2
protective helmet
a device to be worn on the head intended to reduce the risk of head injury resulting from the impact while riding on a motorcycle and including
a) a shock-attenuating system;
b) the retention system;

2.2
shell (outer covering)
the hard part of the protective helmet, which gives it its general shape

2.3
protective padding
a material used to absorb impact energy

2.4
comfort padding
a material provided for the wearer's comfort

2.5
retention system
the complete assembly by means of which the helmet is maintained in position on the head, including any devices for adjustment of the system or to enhance the wearer's comfort

2.5.1
chin-strap
a part of the retention system consisting of a strap that passes under the wearer's jaws to keep the helmet in

position

2.5.2
chin-cup
an accessory of the chin-strap that fits round the point of the wearer's chin

2.6
peak
an extension of the shell above the eyes

2.7
lower face cover
a detachable, movable or integral (permanently fixed) part of the helmet covering the lower part of the face;

2.7.1
protective lower face cover
a detachable, movable or integral (permanently fixed) part of the helmet covering the lower part of the face and intended to protect the chin of the user against impacts

2.7.2
non protective lower face cover
a detachable or movable part of the helmet covering the lower part of the face that does not protect the chin of the user against impacts

2.8
visor
a transparent protective screen extending over the eyes and covering all or part of the face

2.9
goggles
transparent protectors that enclose the eyes

2.10
disposable protective film
a removable plastic film that may be applied to protect the visor prior to use. The film has to be opaque or printed and is removed before use

2.11
ocular areas
two circles of minimum diameter 52 mm spaced symmetrically about the vertical centre line of the visor, the distance between the centres of the circles being 64 mm measured in the horizontal front plane of the visor as worn

2.12
luminous transmittance “τv"
is defined in annex C

2.13
relative visual attenuation quotient
the relative visual quotient (Q) and is defined in annex C.

2.14
basic plane of the human head
a plane at the level of the opening of the external auditory meatus (external ear opening) and the lower edge of the orbits (lower edge of the eye sockets)

2.15
basic plane of the head form
a plane which corresponds to the basic plane of the human head

2.16
reference plane
a construction plane parallel to the basic plane of the head form at a distance from it which is a function of the size of the head form

2.17
helmet positioning index (HPI)
the vertical distance measured at the median plane, from the front edge of the helmet to the basic plane, when the helmet is placed on the reference headform

2.18
horizontal plane
plane that passes across the body at right angles to both the frontal and median plane
(See Figure 2)

2.19
maximum value of acceleration, a_{max}
highest point on the acceleration-time curve, encountered during impact, in units of g,

2.20
median plane
vertical plane that passes through the headform from front to back and divides the headform into right and left halves (See Figure 2).

2.21
"g"
acceleration due to gravity (9.81m/s^2)

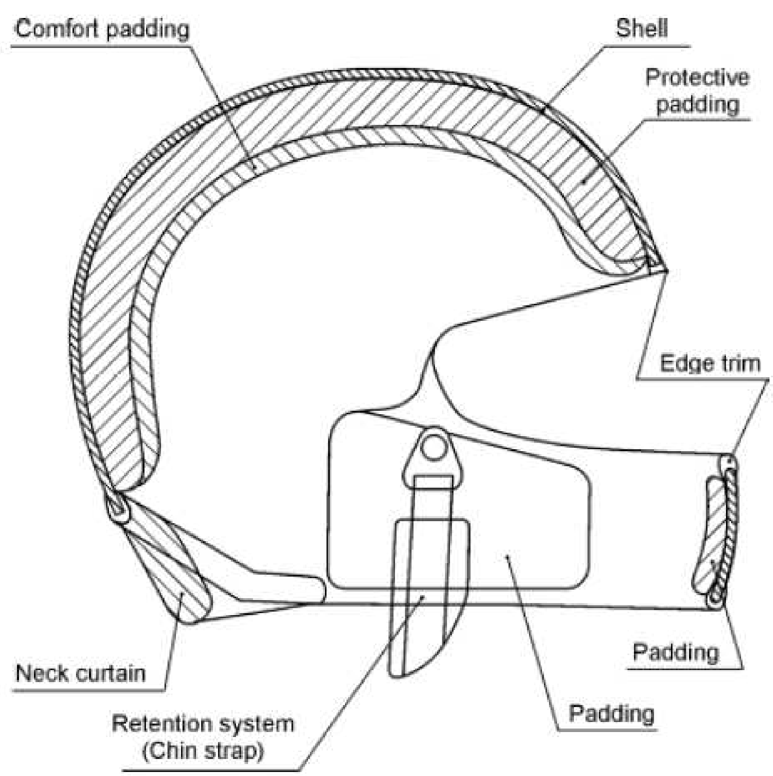


Figure 1 – Helmet detail

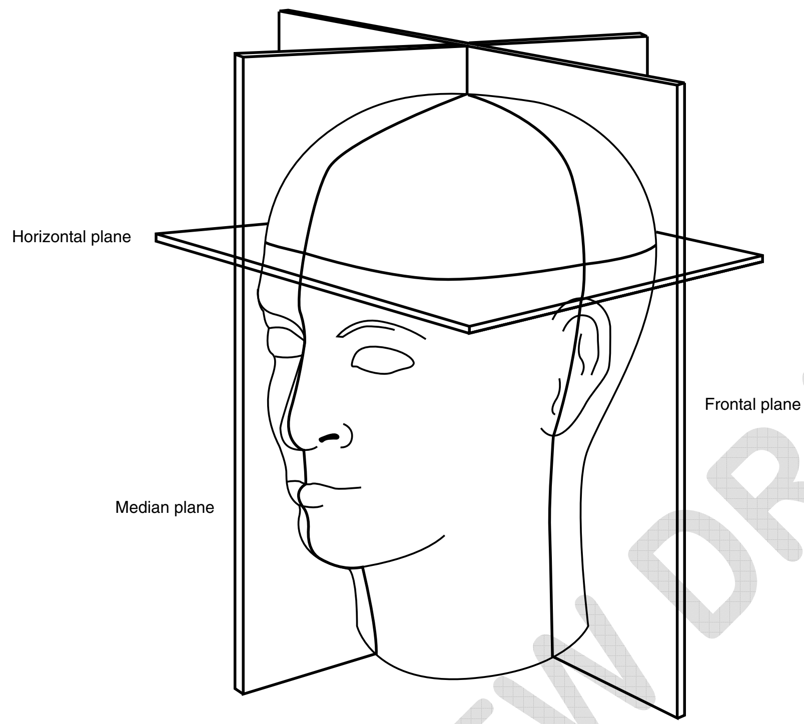


Figure 2: Orientation planes

4 Requirements

4.1 General construction requirements

4.1.1 The basic construction of the helmet shall be in the form of a hard outer shell, containing additional means of absorbing impact energy, and a retention system.

4.1.2 No component or device may be fitted to or incorporated in the protective helmet unless it is designed in such a way that it will not cause injury and that, when it is fitted to or incorporated in the protective helmet, the helmet still complies with the requirements of this Standard.

4.1.3 The protective helmet may be fitted with ear flaps and a neck curtain. It may also have a detachable peak, and a lower face cover. If fitted with a non protective lower face cover the outer surface of the cover shall be marked "Does not protect chin from impacts" and/or with the symbol shown in figure 1 below indicating the unsuitability of the lower face cover to offer any protection against impacts to the chin.

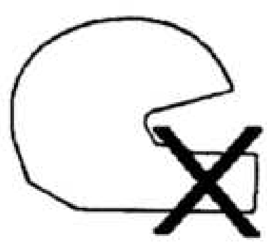
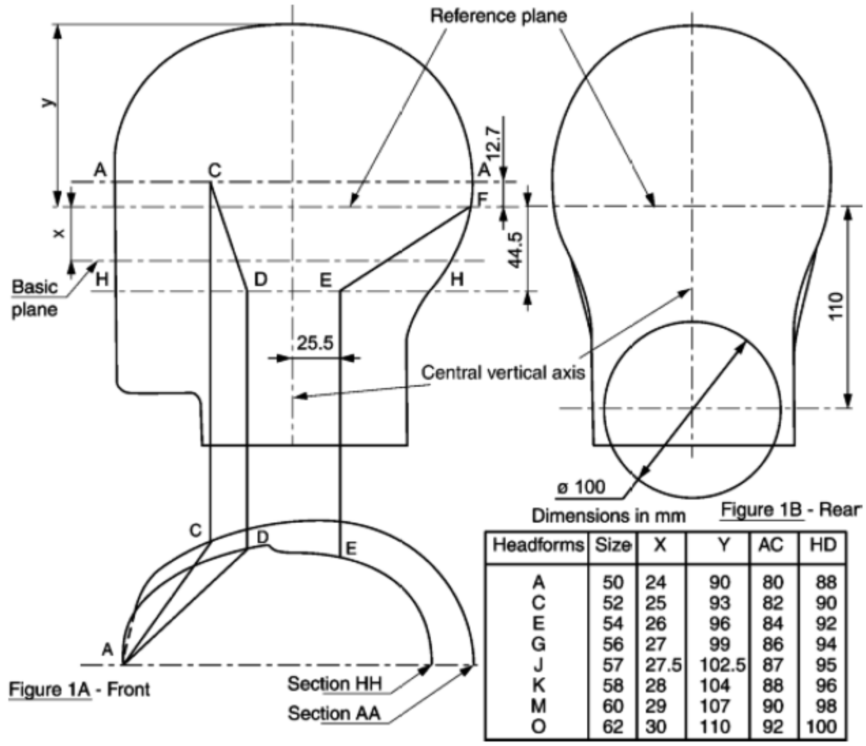


Figure 1: Symbol "Does not protect chin from impacts

4.1.4 The extent of the protection provided shall be as follows:

4.1.4.1 The shell shall cover all areas above plane AA' and shall extend downwards at least as far as the lines CDEF on both sides of the headform (Figure 3 A).



Headforms	Size	X	Y	AC	HD
A	50	24	90	80	88
C	52	25	93	82	90
E	54	26	96	84	92
G	56	27	99	86	94
J	57	27.5	102.5	87	95
K	58	28	104	88	96
M	60	29	107	90	98
O	62	30	110	92	100

Figure 3 – Minimum extent of protection

4.1.4.2 At the rear, the rigid parts and, in particular, the shell shall not be within a cylinder defined as follows (see Figure 3 B):

(i) Diameter 100 mm;
(ii) Axis, situated at the intersection of the medium plane of symmetry of the headform and of a plane parallel to and 110 mm below the reference plane.

4.1.4.3 The protective padding shall cover all the areas defined in 4.1.4.1, account being taken of the requirements of 4.1.4.4

4.1.4.4 The helmet shall not dangerously affect the wearer's ability to hear. The temperature in the space between the head and the shell shall not rise inordinately; to prevent this, ventilation holes may be provided in the shell. Where means for attaching a visor are not provided, the profile at the front edge shall not prevent the wearing of goggles.

4.1.3.5 All external projections shall be radiused and any external projections other than press-fasteners shall be smooth and adequately faired.

4.1.3.6 All external projections not more than 2 mm above the outer surface of the shell (e.g. rivet heads) shall have a radius of a minimum of 1 mm.

4.1.3.8 All external projections more than 2 mm above the outer surface of the shell shall have a radius of a minimum of 2 mm.

4.1.3.9 There shall be no inward-facing sharp edges on the inside of the helmet; rigid, projecting internal parts shall be covered with padding so that any stresses transmitted to the head are not highly concentrated.

4.1.3.10 The various components of the protective helmet shall be so assembled that they are not liable to become easily detached as a result of an impact.

4.2 Construction material requirements

4.2.1 All materials used shall be known not to be adversely affected by ordinary household soap and cleaners as recommended by the manufacturer. Paints, glues and finishes used in manufacturing shall be compatible with the materials used in the construction of the helmet and shall not affect the mechanical performance of the helmet according to the related tests in this Standard.

4.2.2 The characteristics of the materials used in the manufacture of helmets shall be known not to undergo appreciable alteration under the influence of ageing, or of the circumstances of use to which the helmet is normally subjected, such as exposure to sun, extremes of temperature and rain. For those parts of the helmet coming into contact with the skin, the materials used shall be known not to undergo appreciable alteration through the effect of perspiration or of toilet preparations. The manufacturer shall not use materials known to cause skin irritations, diseases or troubles. The suitability of a proposed new material shall be established by the manufacturer.

4.2.3 All materials used in the construction of the helmet shall be resistant to irreversible polymeric changes when exposed to temperatures from -10^{o}C to 50^{o}C.

4.2.4 The weight of the helmet shall not exceed 1960 g.

4.2.5 After the performance of any one of the prescribed tests, the protective helmet shall not exhibit any breakage or deformation dangerous to the wearer.

4.3 Resistance to external agent

After each conditioning as described in 5.3, the helmet shall be visually inspected. There shall be no signs of cracking or appreciable distortion of the retro reflective material.

4.4 Retention system

4.4.1 Retention systems shall be protected from abrasion.

4.4.2 The helmet shall be held in place on the wearer's head by means of a retention system which is secured under the lower jaw. All parts of the retention system shall be permanently attached to the system or to the helmet.

4.4.3 If the retention system includes a chin-strap, the strap shall be not less than 20 mm wide under a load of 150 ± 5 N.

4.4.4 The chin strap may not include a chin-cup since the latter is integral with the shell.

4.4.5 Chin straps shall be fitted with a device to adjust and maintain tension in the strap.

4.4.6 If a retention system includes a quick-release mechanism, then the method of release of this mechanism shall be self-evident. Any levers, tabs, buttons or other components which need to be operated to release the mechanism shall be coloured red, those parts of the rest of the system which are visible when closed shall not be similarly coloured, and the mode of operation shall be permanently indicated.

4.4.7 The buckle of the retention system shall be designed so as to preclude any possibility of incorrect manipulation. It shall not be possible for the buckle to be left in a partially closed position.

4.5 Test requirements

4.5.1 Extent of protection

The entire area of the helmet above the test line stipulated in 5.5 shall attenuate impact energy to the minimum requirements specified in 4.5.5.

4.5.2 Peripheral vision

All helmets shall allow unobstructed vision through a minimum of 105^o to the left and right sides of the median plane when measured in accordance with the procedures described in 5.7.

4.5.3 Penetration resistance

When tested in accordance with 5.8 at ambient temperature, no contact with the test headform by the test dowel shall be made within any aperture on the helmet.

4.5.4 Effectiveness of retention system

When tested in accordance with 5.9, at ambient temperature the helmet shall remain on the test headform.

4.5.5 Strength of retention system

When tested in accordance with 5.10, the retention system shall not detach and the maximum elongation of the retention system shall not exceed 25 mm when measured between preliminary and test load positions.

4.5.6 Sound attenuation

When measured in accordance with 5.13, the sound drop shall not be more that 10 dB.

4.5.7 Rigidity

When tested in accordance with 5.12:

a) In the test along each axis, the deformation measured under the 630 N load shall not exceed that measured under the initial 30 N load by more than 40 mm.

b) After restoration of the 30 N load, the deformation measured shall not exceed that measured under the initial 30 N load by more than 15 mm.

4.5.8 Shock absorption

When the helmet is tested in accordance with **5.11,** the peak headform acceleration (a_{max}) shall not exceed 275 *g*.

4.5.9 Visors

4.5.9.1 General requirements for visors

4.5.9.1.1 The systems of attachment of a visor to a helmet shall be such that the visor is removable. It must be possible to manoeuvre the visor out of the field of vision with a simple movement of one hand.

4.5.9.1.2 Visors shall be free from any significant defects likely to impair the vision, such as bubbles, scratches, inclusions, dull spots, holes, mould marks, scratches or other defects originating from the manufacturing process in the field of vision.

4.5.9.1.3 Visors shall in addition be sufficiently transparent, shall not cause any noticeable distortion of object as seen through the visor, shall be resistant to abrasion, not easily broken and shall not give rise to any confusion between the colour used in road traffic sign and signals.

4.5.9.2 Test requirements for visors

4.5.9.2.1 Field of vision

4.5.9.2.1.1 The visor shall not comprise any part liable to impair the user's peripheral vision as defined in 4.5.2 when the visor is in the totally opened position.

4.5.9.2.1.2 The field of vision of the visor shall be:

(a) A dihedron defined by the reference plane of the headform and a plane forming an angle of at least 7° upwards, its edge being the straight line L1 L2, with points L1 and L2 representing the eyes,

(b) Two segments of dihedral angles symmetrical to the median vertical longitudinal plane of the headform. Each of these dihedral angles is defined by the median vertical longitudinal plane of the headform and the vertical plane forming with this plane an angle of 90°, its edge being the straight line LK,

(c) and the lower edge of the visor.

4.5.9.2.1.3 To determine the field of vision as defined in 4.5.9.2.1.2 above, the helmet fitted with the visor being tested shall be placed on a test headform of suitable size with the helmet tipped towards the rear and the visor placed in the closed position.

4.5.9.2.2 Luminous transmittance

Visors shall have a luminous transmittance τv 80%, relative to the standard illuminant D65 when measured in accordance with **Annex B**

4.5.9.2.3 Light diffusion

The light diffusion shall not exceed the limit in table 1 when measured accordance with 5.14.2.1.2 using one of the methods specified in annex B

Table 1 — Light diffusion limits

Before abrasion		After abrasion	
0.65 $cd/m^2/l$	a/ c/	5.0 $cd/m^2/l$	a/ c/
2.5%	b/	20%	b/

a/ measured according to annex B, method (a);
b/ measured according to annex B, method (b);
c/ measured according to annex B, method (c).

If different results arise when this is assessed, the requirements on scattered light shall be measured and assessed over an area 5 mm in diameter which includes the presumed error. In addition, the regular transmittance shall not deviate by more than 5 per cent from the reference value, measured in one of two sight points specified in 4.5.9.3.6, at any point within the field of vision of the visor.

4.5.9.2.4 Reception of signal lights

The relative attenuation quotient shall be measured by the method given in 5.14.2.1.1, before the abrasion test. The relative visual attenuation quotient (Q) shall not be less than:

0.80 for red and yellow signal lights;
0.60 for green signal light;
0.40 for blue signal light.

4.5.9.2.5 Spectral transmittance

In the range 500 nm to 650 nm, the spectral transmittance, measured by the method given in 5.14.2.1.1, shall not be less than 0.2 τ_v. The spectral transmittance shall be measured before the abrasion test.

4.5.9.2.6 Refractive powers

The table contains the permissible refractive powers at the sight points. The sight points are located in the reference plane 32 mm to the right and the left of the longitudinal median plane (see Figure 2).

Permissible refractive power values for visors

Spherical effect	Astigmatic effect	Prismatic effect difference		
$\frac{D_1 + D_2}{2}$	$\lvert D_1 - D_2 \rvert$	Horizontal		Vertical
		Base Out	Base In	
m^{-1}	m^{-1}	cm/m	cm/m	cm/m
••0.12	0.12	1.00	0.25	0.25

D1, D2: Refractive effect in two main sectors
The requirements for the prismatic effect apply to the difference between the values at the two sight points.
The refractive powers shall be measured according to method specified in annex E.

4.5.9.2.7 Mist retardance

The internal face of the visor is regarded as having a mist retardant facility if the square of the specular transmittance has not fallen below 80 per cent of the initial value without misting within 20 s when tested in accordance with annex F. Such facility may be indicated by the English words “MIST RETARDANT”.

4.5.9.2.8 Mechanical properties

When tested in accordance with 5.14.1.3.3, the test piece shall then be subjected to the abrasion test described in annex A, during which 3 kg of abrasive material shall be projected at the sample.

4.5.9.2.9 Optical quality and scratch resistance

When tested in accordance with annex B, visors shall have a luminous transmittance □□$_v$ 80%, relative to the standard illuminant D65.

5 Test methods

5.1 General

Helmets shall be capable of meeting the requirements in this Standard throughout their full range of available sizes. Each helmet shall be tested on the headform size of best fit. All testing shall be done with the visor and all accessories removed (if applicable).

5.2 Samples for testing

In order to determine whether a lot of protective helmets containing up to 500 helmets of one class, type, size and origin, complies with the standard, a sample of 6 helmets shall be taken at random from the lot and tested as per the test schedule specified in 5.6.

5.3 Conditioning environments

Helmets shall be conditioned to one of the following environments prior to testing in accordance with the test schedule specified in 5.6. All test helmets shall be stabilized within the ambient condition for 4 to 6 hours prior to further conditioning and testing.

5.3.1 Ambient conditioning

The sample shall be exposed to a temperature of 23 ± 5˚C and a relative humidity not exceeding 75 % for 4 to 6 hours.

5.3.2 Low temperature conditioning

The sample shall be exposed to a temperature of -10± 3˚C for 4 to 6 hours. Testing shall begin within 60 s of removal from the low temperature conditioning chamber. Complete all helmet testing within 5 minutes after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement. Helmets shall remain in the conditioning environment for 15 minutes for each 5 minutes that they are out of the conditioning environment.

5.3.3 Elevated temperature conditioning

The sample shall be exposed to a temperature of 50 ± 2˚C for 4 to 6 hours. Testing shall begin within 60 s of removal from the elevated temperature conditioning chamber. Complete all helmet testing within 5 minutes after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement. Helmets shall remain in the conditioning environment for 15 minutes for each 5 minutes that they are out of the conditioning environment.

5.4 Test headforms

A headform, capable of accepting an accelerometer mounted at its centre of gravity and conforming to the requirements of a three quarter headform as defined in EN 960, shall be used. Headforms used for impact testing shall be rigid and be constructed of low resonance K–1A magnesium alloy. The headform and supporting assembly shall have a total combined mass as described in the following table, with the supporting assembly contributing to no more than 25% of the total mass.

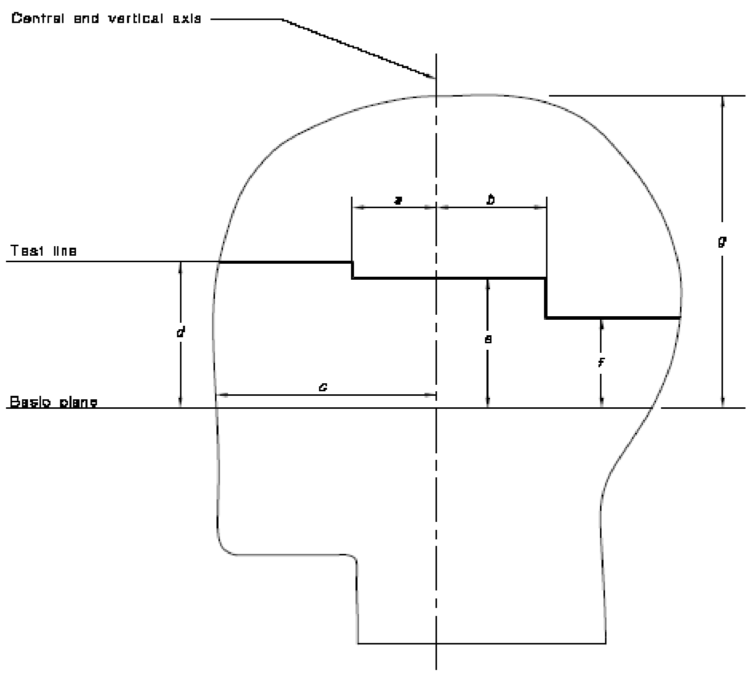
Table1 — Test headforms

Headform label	Size Designation	Mass
A	495 mm	3.10 kg ± 0.10 kg
E	535mm	4.10 kg ±0.12 kg
J	575mm	4.70 kg ±0.14 kg
M	605mm	5.60 kg ±0.16 kg
O	625mm	6.10 kg ±0.18 kg

5.5 Marking the test line

A reference headform that is firmly seated with the basic plane horizontal shall be used for reference marking. The complete helmet to be tested shall be placed on the applicable reference headform whose circumference is not greater than the internal circumference of the headband when adjusted to its largest setting, or, if no headband is provided, to the corresponding interior surface of the helmet.

The helmet shall be positioned on the reference headform and a static force of 50 N shall be applied normal to the apex of the helmet. The helmet shall be centred laterally and seated firmly on the applicable reference headform according to its helmet positioning index (HPI). If the HPI and corresponding headform size are not available from the manufacturer, the test technician shall choose the headform and HPI value. Maintaining the force and position described above, a test line shall be drawn on the outer surface of the helmet coinciding with that on the headform as shown in Figure 4.



Headform Label	Dimensions (mm)						
	a	b	c	d	e	f	g
A (495 mm)	23	65	88	59	34.5	26.5	113.5
E (535 mm)	29.5	65	94.5	64	39	33	122
J (575 mm)	36	65	101	66	41	36	130
M (605 mm)	41	65	106	67	41.5	37	136
O (625 mm)	43.5	65	108.5	68	42	38	140

Figure 4 — Extent of protection and test lines

5.6 Test schedule

5.6.1 Helmet samples shall be tested according to the test schedule shown in Table 2. The sequence of testing shall be as follows:

1. Peripheral vision test (if applicable)
2. Penetration resistance test (if applicable)
3. Effectiveness of retention system test (if applicable)
4. Strength of retention system test
5. Shock absorption test
6. Sound attenuation test
7. Rigidity test

Table 2 — Helmet test schedule

Sample	Peripheral vision test	Penetration resistance test	Effectiveness of retention system test	Strength of retention system test	Shock absorption test	Sound attenuation test	Rigidity test
Helmet 1 – Ambient Temperature	X	X		X	X		
Helmet 2 – Low Temperature				X	X		
Helmet 3 – Elevated Temperature				X	X		
Helmet 4 – Water Immersion				X	X		
Helmet 5 – Ambient Temperature			X			X	X

5.6.2 Visor samples shall be tested according to the test schedule shown in Table 3.

Table 3 — Visor test schedule

Sample	Field of vision	Luminous Transmittance, Light diffusion, Recognition of signal lights, Spectral transmittance	Refractive powers	Mist retardant visor	Mechanical characteristics	Optical quality and scratch resistance
Visor 1	x	x				x
Visor 2			x		x	
Visor 3			x		x	
Visor 4				x		
Visor 5		x				x

5.7 Peripheral vision test

Position the helmet on a reference headform in accordance with the HPI and place a 50N preload ballast on top of the helmet to set the comfort or fit padding. (Note: peripheral vision clearance may be determined when the helmet is positioned for marking the test lines). Peripheral vision is measured horizontally from each side of the median plane around the point K (see Figure 5). Point K is located on the front surface of the reference headform at the intersection of the basic and median planes. The vision shall not be obstructed within 105 degrees from point K on each side of the median plane. Measurement may be performed with a physical measuring device (i.e. peripheral vision template or a test headform with point K clearly marked) or with laser measurement equipment.

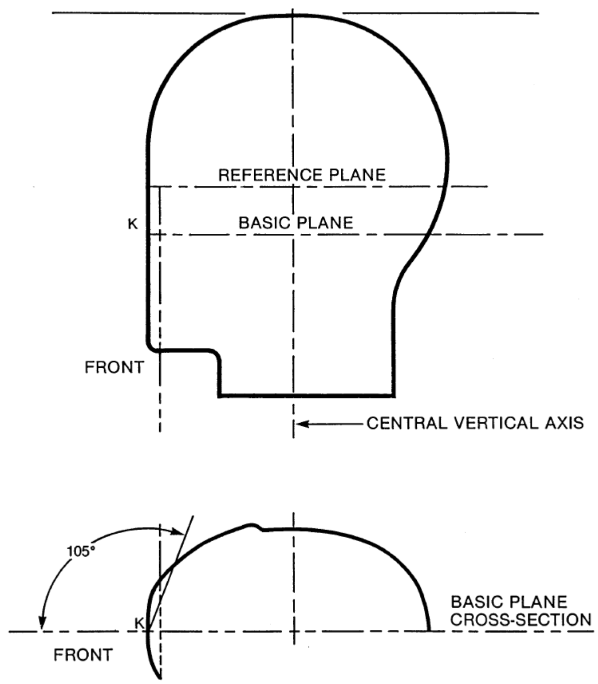


Figure 5 — Peripheral vision test

5.8 Penetration resistance test

5.8.1 Apparatus

The apparatus for the penetration test shall include a full size reference headform that meets the requirements of EN 960:2006.

5.8.2 Method

Position the helmet on a reference headform in accordance with the HPI and place a 50N preload ballast on top of the helmet to set the comfort or fit padding. Using a metal test dowel with a diameter of 20mm (see Figure 6) attempt to make contact with the headform by trying to enter any part of the metal dowel end through all of the openings of the helmet. Record the location of any metal dowel to headform contact.

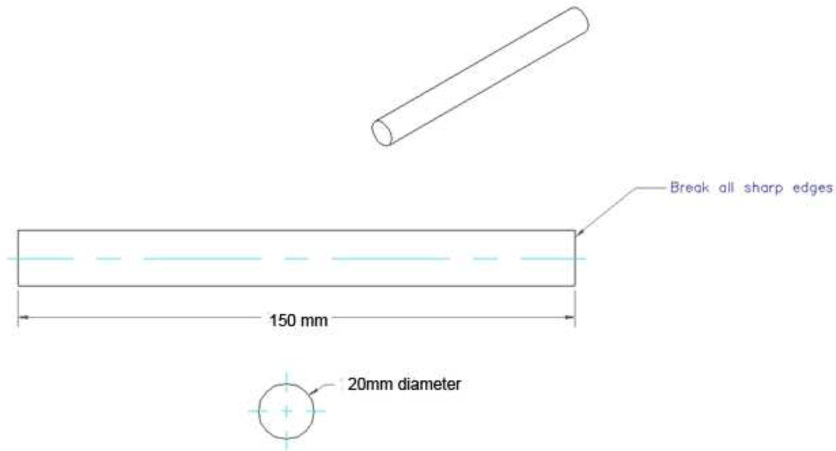


Figure 6 — Metal Dowel for Penetration Test

5.9 Retention system effectiveness test

5.9.1 Apparatus

The apparatus for the retention system effectiveness test shall include a full size reference headform that meets the requirements of **EN960:2006.**

5.9.2 Method

Secure the reference headform to a fixture that will prevent headform movement when a tangential force is applied to the helmet. Position the helmet on a reference headform in accordance with the manufacturer's instructions. A flexible strap and hook mechanism shall be attached to the front lower edge of the helmet such that it is in line with the mid-sagittal plane. The total mass of the falling weight guide apparatus shall be 3 ± 0.1 kg and shall be able to accommodate drop heights up to 100 cm. A 10 ± 0.1 kg drop weight shall then be raised to a height of 50 cm ± 0.5 cm and released (see Figure 7).

This procedure shall be repeated with the hook mechanism attached to the rear edge of the helmet.

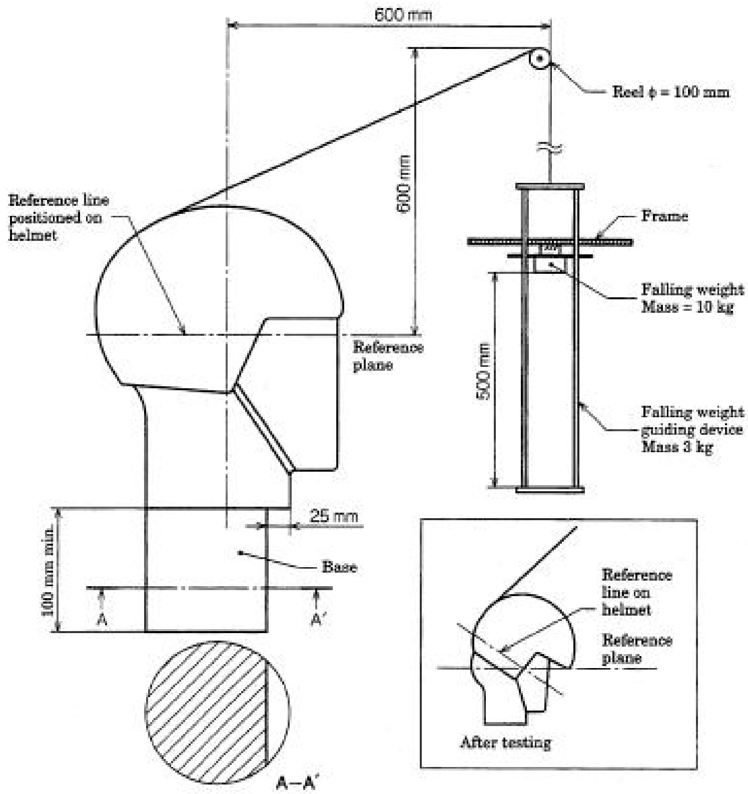


Figure 7 — Typical retention system effectiveness test apparatus

5.10 Retention system strength test

5.10.1 Apparatus

Retention system strength test device consists of both an adjustable loading mechanism by which a static tensile load is applied to the helmet retention assembly and a means for holding the test headform and helmet stationary. The retention system test device shall allow the retention assembly to be fastened around two freely moving rollers, both of which have a 12.5 mm diameter and a 75 mm centre-to-centre separation, and which are mounted on the adjustable portion of the tensile loading device (see Figure 8).

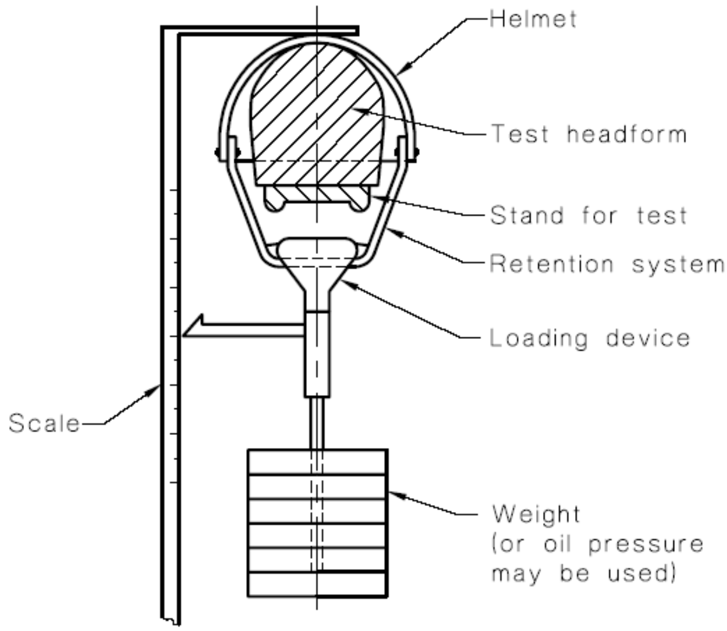


Figure 8: Typical retention system strength test apparatus

5.10.2 Method

Place the subject helmet on the test headform such that the basic plane is normal to the force of gravity and adjust it in accordance with the manufacturer's HPI. Securely fasten the retention system around the two freely moving rollers in a manner that avoids contact between the rollers and helmet's buckle. Apply a preliminary load of 45 ± 3 N in the direction normal to the basic plane to the retention system and hold for a minimum of 30 seconds. Record the displacement measurement on the moveable test device. Increase the load to 500 ± 5 N and maintain this load for 120 seconds, + 0 seconds, - 10 seconds by adjusting the load applied to the retention system as necessary. After 120 seconds (+0 seconds, -10 seconds) at full test load, measure and record the displacement measurement of the retention system. The maximum elongation shall be the difference between the initial measurement and the measurement taken after 120 seconds.

5.11 Shock absorption test

5.11.1 Apparatus

The test apparatus for the shock absorption test shall consist of the following:

(a) The headform employed in this test shall conform to all requirements under 5.4.

(b) The test headform shall be mounted on a guided freefall system as shown in Figure 8 with an adjustable mounting for the helmeted headform to permit impacts to be delivered to any location on the helmet at or above the test line. A monorail guided freefall system shall also be acceptable. The total mass of this support assembly shall not exceed 25% of the combined mass of the drop assembly (i.e., supporting assembly plus the test head-form). The centre of gravity of the drop-assembly unit shall lie within a cone having a vertical axis and forming at most a 10 degree included angle with the vertex as the point of impact.

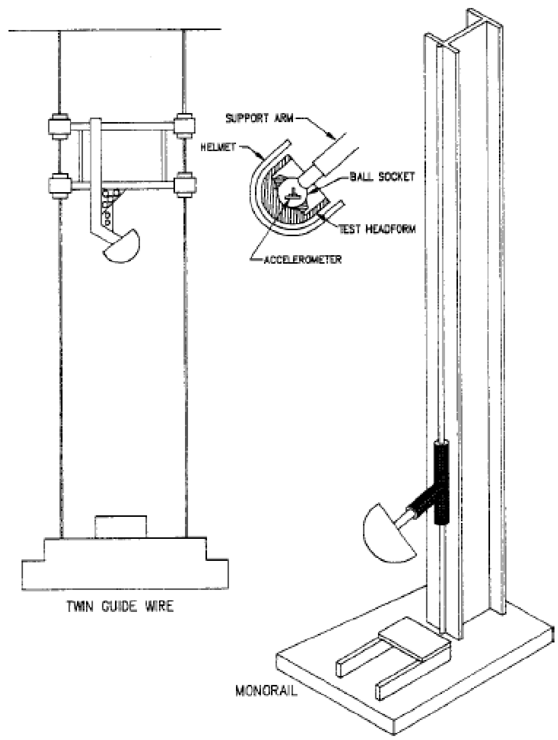


Figure 9 — Typical drop assembly apparatus

(c) A linear accelerometer shall be placed at the centre of gravity of the test head-form and its sensitive axis shall be aligned to within 5 degrees of the vertical when the helmet and headform are in the impact position. The accelerometer shall be capable of withstanding a maximum acceleration of 1000 *g* without damage and shall have a frequency response of at least 5 to 900 Hz. A triaxial accelerometer with identical performance specifications is also acceptable.

(d) The flat anvil shall be made of steel or another similar rigid metal and shall be firmly attached to the base of the drop assembly. The impact face shall have a minimum diameter of 150 mm.

(e) The hemispherical anvil shall be made of steel or another similar rigid metal and shall be firmly attached to the base of the drop assembly. The hemispherical anvil shall have a hemispherical impact surface with a radius of 48 ± 1 mm.

(f) The rigid mount for the anvils shall consist of a solid mass of at least 135 kg, the upper surface of which shall consist of a steel plate with a minimum thickness of 12 mm and minimum surface area of 0.1 m^2.

(g) The data acquisition system shall be capable of collecting impact data at a rate of not less than 10 kHz per channel. The measuring system, including the drop assembly, shall have a frequency response in accordance with channel frequency class (CFC) 1000 of ISO 6487.

5.11.2 System verification

The shock absorption test instrumentation shall be verified before and after each series of tests (at least at the beginning and end of each test day) by dropping a spherical impactor onto a modular elastomer programmer (MEP) test surface.

The spherical impactor shall be a device made of low resonance material (for example, magnesium), aluminum alloy, or stainless steel that couples mechanically with the ball arm connector of the drop assembly

in place of the impact test headform. When mounted, the device presents a spherically machined impact face with a radius of 73 mm on its bottom surface. All radii from the center of the curvature of the impact face to its outer edge shall form angles of no less than 40° with the downward vertical axis. The center of curvature shall be within 5 mm of the vertical axis drawn through the center of the ball arm. The total mass of the spherical impactor drop assembly shall be 5.0 ± 0.1 kg.

The MEP shall be 152 mm in diameter and 25 mm thick, and shall have a durometer of 60 ± 2 Shore A. The MEP shall be affixed to the top surface of a flat 6.35 mm thick aluminum plate. The geometric center of the MEP pad shall be aligned with the center vertical axis of the accelerometer.

The impactor shall be dropped onto the MEP at an impact velocity of 5.44 m/s ± 2% as measured within the last 40mm of free fall of the impactor. Typically, this requires a minimum drop height of 1.50 metres plus a height adjustment to account for friction losses. Six impacts, at intervals of 75 ± 15 seconds, shall be performed at the beginning and end of the test series (at a minimum at the beginning and end of each test day). The first three of six impacts shall be considered warm-up drops, and their impact values shall be discarded from the series. The second three impacts shall be recorded. All recorded impacts shall fall within the range of 380 g to 425 g. The mean of the 3 post-test results shall not differ by more than 5% from the mean of the pre-test results. Otherwise, the results shall be discarded and the tests repeated with new samples after the source of this difference has been rectified.

The components of the data acquisition system, including all transducers shall be calibrated to traceable national reference standards at an interval of not greater than five years.

5.11.3 Helmet impact test locations

Each helmet shall be tested at four impact locations on or above the test line described in Clause 5.3. Each impact location shall be a distance of at least one-fifth of the circumference of the test headform from any prior impact location on that helmet.

5.11.4 Method

5.11.4.1 The helmet shall be placed on the appropriate headform according to the manufacturer’s helmet positioning index (HPI). The helmet shall be dropped onto the flat anvil with an impact velocity of 6.0 m/s ± 3%. Typically, this requires a minimum drop height of 1.83 metres, plus a height adjustment to account for friction losses.

The helmet shall be dropped onto the hemispherical anvil with an impact velocity of 5.2 m/s ± 3%. Typically, this requires a minimum drop height of 1.38 metres, plus a height adjustment to account for friction losses. The impact velocity shall be measured during the last 25 mm of free-fall for each test. Following impact, the drop assembly shall be raised and the headform shall be oriented to another impact site.

5.9.4.2 The first impact shall be made not more than 60 s after the helmet has been removed from the conditioning environment. Following testing, the helmet shall be immediately returned to its conditioning environment for a minimum of 15 min before another impact test is conducted.

5.12 Rigidity test

The helmet, after undergoing ambient-temperature and hygrometry conditioning, shall be placed between two parallel plates by means of which a known load can be applied along the longitudinal axis 6/ (line LL in the Figure 10) or the transverse axis (line TT in the figure). The surface of the plates shall be large enough to contain a circle of at least 65 mm in diameter. An initial load of 30 N shall be applied, at a minimum plates speed of 20 mm/min, and after two minutes the distance between the two plates shall be measured. The load shall then be increased by 100 N, at a minimum plates speed of 20 mm/min, and then wait for two minutes. This procedure shall be repeated until the application of a load of 630 N.

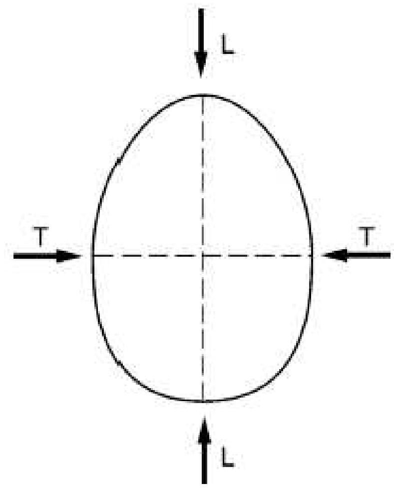


Figure 10 — Rigidity test axes

The load applied to the plates shall be reduced to 30 N, at a minimum plates speed of 20 mm/min; the distance between the plates shall then be measured.

5.12.3. The helmet used for the test along the longitudinal axis shall be a new helmet, and another new helmet shall be used for the test along the transverse axis.

5.13 Sound attenuation test

The sound test is done with a meter mounted inside a helmeted headform at the left or the right ear location. The location should be uninterrupted for 12 m radius without any acoustic materials, as in open ground. A horn is sounded (90-115 dB, ambient sound should be 10 dB or less) 2 metres from the helmet, mounted rigidly 1.2 m off the ground on a stand. The sound level is measured at the sound meter location with and without the helmet covering it.

5.14 Visor tests

5.14.1. Test procedure

5.14.1.1 The test piece shall be taken from the flattest part of the visor in the area specified in 4.5.9.2.1.2 and its minimum dimensions shall be 50 mm x 50 mm. The test shall be carried out on the face corresponding to the outside of the visor.

5.14.1.2 The test piece shall undergo ambient-temperature and hygrometry conditioning in accordance with 5.3.

5.14.1.3 The test shall comprise the following sequence of operations:

5.14.1.3.1 The surface of the test piece shall be washed in water containing 1 per cent detergent and rinsed with distilled or demineralised water, then carefully dried with a grease-free and dust-free linen cloth.

5.14.1.3.2 Immediately after drying and before abrasion, the luminous transmittance shall be measured using the method given in 5.14.2.1.1., and the light diffusion shall be measured according to one of the methods specified in annex B.

5.14.1.3.3 The test piece shall then be subjected to the abrasion test described in annex A, during which 3 kg of abrasive material shall be projected at the sample.

5.14.1.3.4 Following the test, the test piece shall again be cleaned in accordance with 5.14.1.3.1

5.14.1.3.5 Immediately after drying the light diffusion after abrasion shall be measured by using again the same method used in accordance with 5.14.1.3.2 above.

5.14.2 Requirements

5.14.2.1. Three similar test pieces, each from a different visor and taken from the area specified in 4.5.9.2.1.2, shall meet the requirements of 5.14.2.1.1 and 5.14.2.1.2.

5.14.2.1.1 In a parallel beam, with the test specimens being irradiated vertically, determine the spectral transmittance values between 380 nm and 780 nm and then the transmittance and the visual attenuation quotient in accordance with the equations given in annex C.

To calculate the luminous transmittance, the spectral distribution of standard illuminant D65 and the spectral values of the colorimetric 2° standard observer CIE 1931 according to ISO/CIE 10526 shall be used. The product of the spectral distribution of standard illuminant D65 and the spectral values of the colorimetric 2° standard observer CIE 1931 according to ISO/CIE 10526 is given in annex D. Linear interpolation of these values for steps smaller than 10 nm is permissible.

The light diffusion shall not exceed the following values for each method:

6 Acceptance and rejection criteria

Owing to the fact that the destructive nature of part of the tests detailed in the standard does not allow the performance of all the tests on a single helmet, it is not possible by testing a single helmet to determine its compliance with the standard. Shall any of the five sample helmets fail to comply with the relevant requirement of the standard, then the entire lot shall be rejected as not complying with the standard.

7 Labelling, Warnings and Instructions

7.1 Labelling

7.1.1 Helmet markings

Every helmet shall have indelibly printed on it or otherwise permanently affixed to it, the following information, clearly and prominently displayed in no less than 8 point font:

(a) the name of the manufacturer;
(b) website address of the manufacturer or other contact information;
(c) the model name or model number of the product;
(d) the size or size range of the circumference of the helmet, quoted as the circumference (in centimeters) of the head which the helmet is intended to fit; and
(e) the week, year of manufacture of the product

(f) the words, “intended for motorcycle riders” and “fasten the chin strap”

7.1.2 Packaging

The packaging in which the helmet is sold or is to be sold shall have indelibly printed on it or otherwise permanently affixed to it, clearly and prominently displayed, the information required by section 7.1.1.

7.2 Warnings

Every product shall have indelibly printed on it or otherwise permanently affixed to it the following information statements, clearly and prominently displayed:

(a) Words to the following effect: For adequate protection this helmet must fit closely. Purchasers are advised to secure the helmet and to ensure that it cannot be pulled or rolled off the head.

(b) Words to the following effect: This helmet is made to absorb some of the energy of a blow by partial destruction of its component parts and, even though damage may not be apparent, any helmet which has suffered an impact to the head in an accident or received a similar severe blow or other abuse should be replaced.

(c) Words to the following effect: To maintain the full efficiency of this helmet there must be no alteration to the structure of the helmet or its component parts.

(d) For helmets fitted with a single chin strap, words to the following effect: The chin strap must pass underneath the jaw to maintain tension all the time the helmet is in use. The law requires that the helmet be securely fastened to the head.

(e) Words to the following effect: The protection given by this helmet may be severely reduced by the application of paint, adhesive stickers and transfers, cleaning fluids and other solvents. Use only materials recommended by the helmet manufacturer.

7.3 Instructions

Every product shall bear or be accompanied by legible written instructions that clearly state the following information, with line drawings or photographs illustrating the sequence of steps where needed:

(a) how the product is to be fitted and adjusted properly;
(b) how the product is to be assembled, if applicable
(c) how the product should be inspected for deficiencies;
(d) how the product is to be maintained, cleaned and dried; and
(e) how the product is to be stored.

8 Test Report

The test report shall include at least the following information:

(a) the number and year of publication of this Standard;

(b) the name or trademark of the manufacturer or the body taking responsibility for manufacture;

(c) identification details of the protective helmet tested as specified in clause 7.1.1.

(d) illustrations of the front and side of the helmet; a test line should be drawn on the illustration.

(e) results of tests in accordance with Clause 5, including information to clearly identify the impact test locations for each helmet tested;

(f) any evidence that shows conformity with requirements in clause 4 and 5;

(g) date of testing;

(h) name of technician who performed the testing and if applicable, the laboratory manager or supervisor, and;

(i) name of testing laboratory.

Annex A
(normative)
Abrasion test procedure

A.1 Description of the test equipment

The sand spray test equipment consists essentially of that illustrated in Figure A.1. The gravity tube consists of three separate rigid polyvinylchloride tubes (PVC hard) of the same diameter, with two polyamide sieves mounted in between. The sieves should have a mesh size of 1.6 mm. The speed of the turntable shall be 250 + 10 rpm.

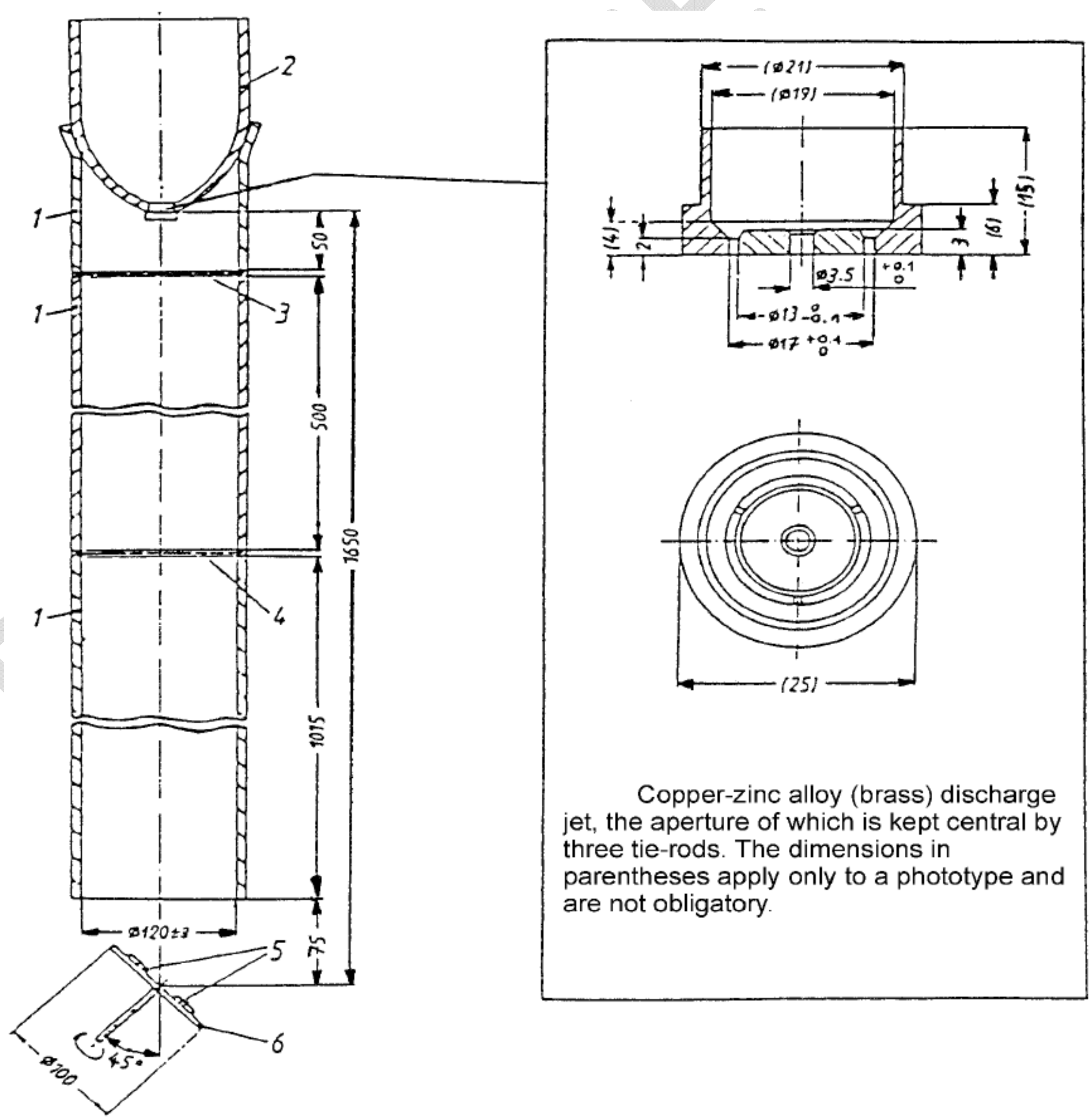
A.2 Abrasive material

Natural quartz sand of a grain size of 0.50/0.7 mm, with no oversize, obtained by sieving on wire sieves complying with ISO 565 with a mesh size of 0.50 mm and 0.7 mm. The sand may be used up to 10 times.

A.3 Test procedure

Three kilograms of 0.50/0.7 mm grain size quartz sand is allowed to drop through a gravity tube from a height of 1,650 mm onto the sample to be tested. The test piece and, if necessary, a control-piece are mounted on a turntable, the axis of which is at a 45°angle to the direction of the sand.

The test pieces are mounted on the turntable in such a way that the area to be measured does not extend beyond the turntable. Whilst the turntable is rotating, 3 kg of sand are allowed to spray over the test pieces.



Copper-zinc alloy (brass) discharge jet, the aperture of which is kept central by three tie-rods. The dimensions in parentheses apply only to a phototype and are not obligatory.

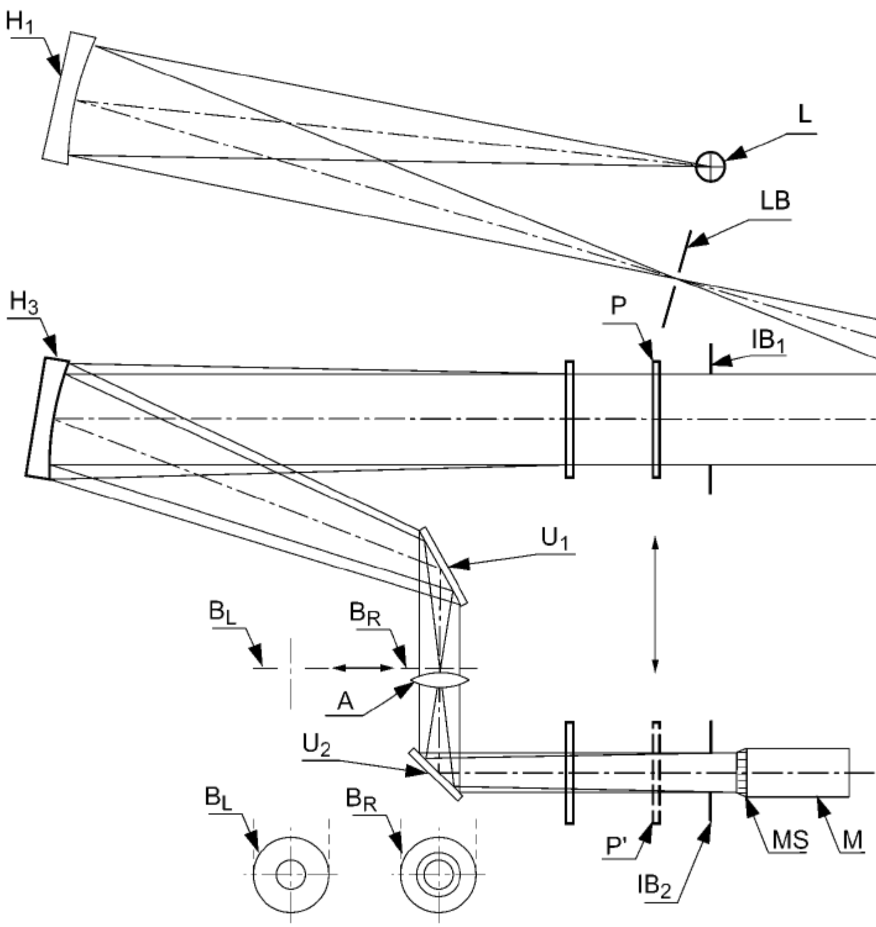
1. Parts of gravity tube
2. Container with discharge jet as figure 2, containing at least 3 kg sand
3. Upper sieve
4. Lower sieve
5. Test piece
6. Test piece holder (turnable)

Figure A.1 — Sand spray equipment

Annex B
(normative)
Methods of measuring light diffusion and light transmission coefficient

B.1 Method (a)

B1.1 Equipment



This assembly collects all the unscattered light originating from the visor up to an angle of 0.72 degree (using diaphragm B_L) and all scattered light between the angles 1.5 degrees and 2 degrees in relation to the optical axis using diaphragm B_R. The angular area is important in the case of night riding, where a range in the immediate proximity of headlights has to be observed. The following dimensions are an information for the possible realization:

L High-pressure xenon lamp (for example XBO 75 W)

H_1 Spherical concave mirror: focal length 150 mm; diameter 40 mm

H_2 Spherical concave mirror: focal length 300 mm; diameter 40 mm

H_3 Spherical concave mirror: focal length 300 mm; diameter 70 mm

A Achromatic lens: focal length 200 mm; diameter 30 mm

U1, U2 Flat mirrors

B_R Annular diaphragm: diameter of outer circle 21.00 mm; diameter of inner circle 15.75 mm

B_L Circular diaphragm: diameter of aperture 7.5 mm

M Silicon detector corrected according to curve V (λ) with diffusing screen MS

IB_1 Iris-diaphragm to adjust diameter of field of observation, diameter 40 mm

IB_2 Iris-diaphragm to eliminate edge effects from IB_1

L_B Circular diaphragm, diameter of aperture 1 mm

P, P' Positions of visor.

Spherical mirror H_1 forms an image of light source L at diaphragm L_B which is in the focal plane of H_2. The concave mirror H_3 forms an image of diaphragm L_B in the plane of diaphragms B_L and B_R. The achromatic lens A is positioned immediately behind the diaphragm so that a reduced image of the test sample in position P appears on diffusing screen MS. The image of iris-diaphragm IB_1 is simultaneously formed on IB2.

B.1.2 Measurement

The visor is positioned in the parallel beam to position P, then diaphragm BL is set in place. The flux T1L falling onto the detector corresponds to the undiffused light transmitted by the sample. Diaphragm BL is then replaced by annular diaphragm BR; flux T1R falling onto the detector corresponds to the total diffused light originating from the visor and from the apparatus. The visor is then placed at position P'. Flux T2R falling onto the detector corresponds to the diffused light coming from the apparatus only.

The visor is then brought out of the light beam (e.g. between P and P'). The flux TOL falling on the detector with the diaphragm BL in place corresponds to the total light.

B.1.3 Optical qualities; definitions

B.1.3.1 Luminous transmittance

$\tau = T_{1L}/T_{OL} \times 100$

B.1.3.2 Light diffusion before abrasion DB:

$DB = 597 \times (T_{1R} - T_{2R})/T_{1L}$

B.1.3.3 Light diffusion after abrasion

$DA = 597 \times (T_{1R} - T_{2R})/T_{1L}$

B.2 Method (b)

2.1. Equipment (See Figure B.1)

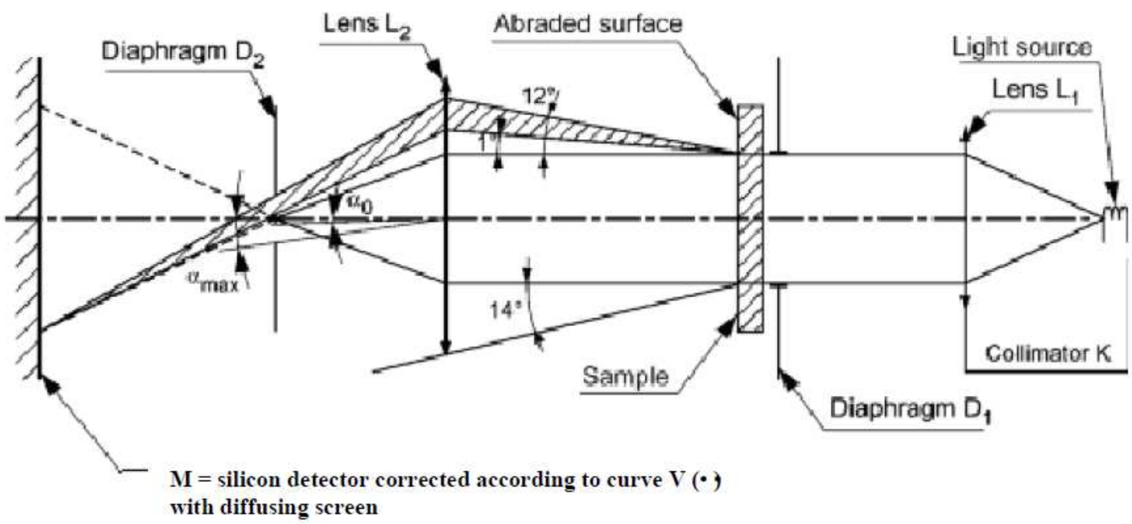


Figure B.1 — Test equipment

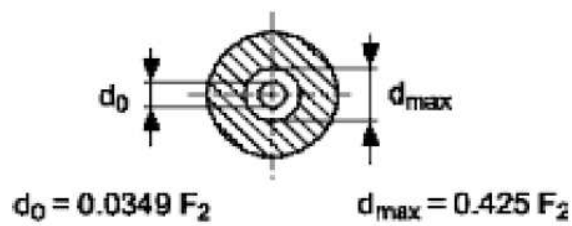


Figure B.2 — Annular diaphragm D_2

The beam of a collimator K of semi-divergence $\gamma/2 = 17.4 \times 10^{-4}$ rd is limited by a diaphragm D_1 with an opening of 12 mm against which the sample holder is placed.

An achromatic convergent lens L_2 corrected for spherical irregularities links the diaphragm D_1 with the receiver R, the diameter of the lens L_2 being such that it does not restrict the light diffused by the sample in a cone with a top half angle of $\beta/2 = 14°$.

An annular diaphragm D2 with extended angles $\alpha_o/2 = 1°$ and $\alpha_{max}/2 = 12°$ is placed in a focal image plane of the lens L_2 (see Figure B.2).

The non-transparent central part of the diaphragm is necessary to eliminate the light arriving directly from the light source. It must be possible to move the central part of the diaphragm away from the light beam in such a manner that it returns exactly to its original position.

The distance between the lens L_2 and the diaphragm D_1, and the focal length F_2[1] of the lens L_2 are to be chosen so that the image of D_1 completely covers the receiver R.

For an initial incident flux of 1,000 units, the absolute precision of each reading shall be better than 1 unit.

[1] For L_2 a focal diameter of about 80 mm is recommended.

B.2.2 Measurements

The following reading shall be taken:

Reading (T)	With sample	With central part of D_2	Quantity represented
T_1	no	no	Incident flux in initial reading
T_2	yes (before abrasion)	no	Flux transmitted by the new material
T_{30}	no	yes	Incident light flux with central part of D_2
T_{31}	yes (before abrasion)	yes	Flux diffused by the new material
T_4	yes (after abrasion)	yes	Flux diffused by the abraded material

B.2.3 Optical quantities definitions

B.2.3.1 The luminous transmittance is given by:

$(T_2/T_1) \times 100$

B.2.3.2 The light diffusion before abrasion is given by:

$DB = (T_{31} - T_{30}) \times 100/T_2$

B.2.3.3 The light diffusion after abrasion is given by:

$DA = (T_4/T_2) \times 100$

Note: Markings DA and DB correspond to paragraph B.1.3 of this annex.

B.3 Method (c)

B.3.1 Equipment

The test arrangement is shown in Figure B.3.

NOTE 1 The measurement principle is identical to the method (a), but the diameter of the measuring is smaller (approximately 2.5 mm) and the test arrangement is simplified.

The beam of the laser (L) is expanded using the two lenses L1 and L2 and is directed towards the measuring point of the ocular (P). Ocular (P) is positioned in such a way what it can rotate around the axis of the beam.

The deviation of the beam is a function of the prismatic refractive power at the measuring point.

The annular or circular diaphragm, whichever is chosen, is at a distance of (400 ± 2) mm from the centre of the ocular. The lens A then produces the image of the centre of the ocular on the photoreceptor S.

The part of the test arrangement, comprising the diaphragms, the lens and the receptor is designed to rotate about the vertical axis through the centre of the ocular.

The ocular and the detector part of the apparatus has to pivot in order to compensate for any prismatic refractive power of the ocular.

NOTE 2 For oculars without corrective effect, it is not necessary, in most cases, for the ocular and the detector part to pivot.

B.3.2 Procedure

B3.2.1 Calibration of the apparatus

Set up the apparatus, the essential features of which are shown in Figure B.3, without the ocular in place. Put the annular diaphragm B_R in place. Rotate the detector part of the apparatus (consisting of a photoreceptor S, a lens A and the annular diaphragm BR) horizontally about P so as to align the light beam from the beam expander (consisting of a lens L_1, with a typical focal length of 10 mm, a lens L2 with a typical focal length of 30 mm and a circular diaphragm B with a pinhole of sufficient size so as to provide a uniform beam) with the centre of the annular diaphragm B_R. Measure the flux Φ_{1R} falling onto the photoreceptor S, corresponding to the total non-diffused light. Replace the annular diaphragm B_R by the circular diaphragm B_L.

Measure the flux Φ_{1L} falling onto the photoreceptor, corresponding to the total non-diffused light.

Obtain the reduced luminance factor for the apparatus, I_a* for the solid angle ω using the following equation:

$$I_a^* = \frac{1}{\omega} \cdot \frac{\Phi_{1R}}{\Phi_{1L}}$$

Where Φ_{1R} is the luminous flux without the visor in the parallel beam and with the annular diaphragm B_R in place

Φ_{1L} is the luminous flux without the visor in the parallel beam and with circular diaphragm B_L in place

ω is the solid angle defined by the annular diaphragm B_R

B.3.2.2 Testing of the visor

Place the visor in the parallel beam at position P as shown in figure 3. Repeat B.3.2.1 with the visor in place and with the visor rotated about the axis of the beam to a position such that the prismatic deviation by the visor is horizontal. Rotate the detector part of the apparatus so that the light beam falls on the centre of BR. Obtain the reduced luminance factor for the apparatus including the visor, I_g* , for the solid angle ω using the following equation:

$$I_g^* = \frac{1}{\omega} \cdot \frac{\Phi_{2R}}{\Phi_{2L}}$$

where Φ2R is the luminous flux with the visor in the parallel beam and with the annular diaphragm BR in place

Φ2L is the luminous flux without the visor in the parallel beam and with circular diaphragm BL in place

ω is the solid angle defined by the annular diaphragm B_R

Then calculate the reduced luminance factor I* of the ocular using the following equation:

$$I^* = I_g^* - I_a^*$$

$$I^* = I_g^* - I_a^*$$

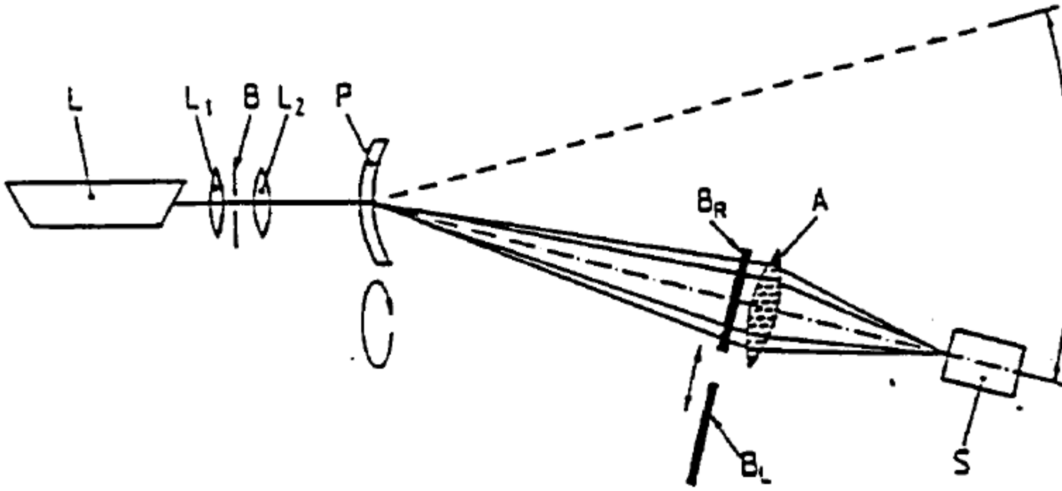


Figure B.3 — Arrangement of apparatus for measurement of light diffusion — Method (c)

L = Laser with wavelength of (600 ±70) nm.
Note: Class 2 laser recommended.
< 1mW. Diameter of beam between 0.6 and 1 mm

L_1 = 10 mm nominal focal length lens

L_2 = 30 mm nominal focal length lens

B = Circular diaphragm - (a hole of 0.1 mm approx produces a uniform light beam)

P = Visor sample

B_R = Annular diaphragm, the diameter of the external circle being (28.0 " 0.1) mm and the inner circle (21.0 " 0.1) mm. See Note 2 below.

B_L = Circular diaphragm of 10 mm nominal diameter

A = Lens, 200 mm nominal focal length and 30 mm nominal diameter

S = Photoreceptor

The distance between the annular/circular diaphragm and the centre of the ocular shall be (400±2) mm.

NOTE 1 The focal lengths of the lenses are only given as a guide. Other focal lengths may be used, for example, if a wider beam is desired or a smaller image of the sample is to be formed on the receptor.

NOTE 2 The diameters of the annular diaphragm circles shall be measured to an uncertainty not exceeding 0.01 mm in order that the solid angle ω may be determined accurately; any deviation from the nominal diameters shall be taken into account by calculation.

Annex C
(normative)
Definitions

The luminous transmittance τv is defined as:

$$\tau_V = \frac{\int_{380nm}^{780nm} S_{D65\lambda}(\lambda) \cdot V(\lambda) \cdot \tau_F(\lambda) \cdot d\lambda}{\int_{380nm}^{780nm} S_{D65\lambda}(\lambda) \cdot V(\lambda) \cdot d\lambda}$$

The relative visual attenuation quotient Q is defined as:

$$Q = \frac{\tau_{sign}}{\tau_V}$$

where:

τv is the luminous transmittance of the visor relative to the standard illuminant D65

τsign is the luminous transmittance of the visor relative to the spectral power distribution of the traffic signal light and it is given by the following equation:

$$\tau_{sign} = \frac{\int_{380nm}^{780nm} S_{A\lambda}(\lambda) \cdot V(\lambda) \cdot \tau_F(\lambda) \cdot \tau_S(\lambda) \cdot d\lambda}{\int_{380nm}^{780nm} S_{A\lambda}(\lambda) \cdot V(\lambda) \cdot \tau_S(\lambda) \cdot d\lambda}$$

where:

SAλ (λ) is the spectral distribution of radiation of CIE standard illuminant A (or 3200 K light source for blue signal light). See: ISO/CIE 10526, "CIE standard colorimetric illuminants";

SD65λ (λ) is the spectral distribution of radiation of CIE standard illuminant D65. See: ISO/CIE 10526, "CIE standard colorimetric illuminants";

V(λ) is the spectral visibility function for daylight vision. See: ISO/CIE 10527, "CIE standard colorimetric observers";

τS (λ) is the spectral transmittance of the traffic signal lens;

τV (λ) is the spectral transmittance of the visor.

The spectral value of the product of the spectral distributions (SAλ (λ) ⊕ SD65λ (λ)) of the illuminant, the spectral visibility function V(λ) of the eye and the spectral transmittance τS (λ) of the traffic signal lenses are given in annex D.

Annex D
(normative)
Products of the spectral distribution of radiation of the signal lights and Standard illuminant D65 as specified in ISO/CIE 10526 and the spectral visibility function of the average human eye for daylight vision as specified in ISO/CIE 10527

Table D.1

Wavelength nm	$S_{A\lambda}(\lambda) \cdot V(\lambda) \cdot \tau_s(\lambda)$				$S_{D65\lambda}(\lambda) \cdot V(\lambda)$
	red	yellow	green	blue	
380	0	0	0	0.0001	0
390	0	0	0	0.0008	0.0005
400	0	0	0.0014	0.0042	0.0031
410	0	0	0.0047	0.0194	0.0104
420	0	0	0.0171	0.0887	0.0354
430	0	0	0.0569	0.3528	0.0952
440	0	0	0.1284	0.8671	0.2283
450	0	0	0.2522	1.5961	0.4207
460	0	0	0.4852	2.6380	0.6888
470	0	0	0.9021	4.0405	0.9894
480	0	0	1.6718	5.9025	1.5245
490	0	0	2.9976	7.8862	2.1415
500	0	0	5.3553	10.1566	3.3438
510	0	0	9.0832	13.0560	5.1311
520	0	0.1817	13.0180	12.8363	7.0412
530	0	0.9515	14.9085	9.6637	8.7851
540	0	3.2794	14.7624	7.2061	9.4248
550	0	7.5187	12.4687	5.7806	9.7922
560	0	10.7342	9.4061	3.2543	9.4156
570	0	12.0536	6.3281	1.3975	8.6754
580	0.4289	12.2634	3.8967	0.8489	7.8870
590	6.6289	11.6601	2.1640	1.0155	6.3540
600	18.2382	10.5217	1.1276	1.0020	5.3740
610	20.3826	8.9654	0.6194	0.6396	4.2648
620	17.6544	7.2549	0.2965	0.3253	3.1619

Wavelength nm	$S_{A\lambda}(\lambda) \cdot V(\lambda) \cdot \tau_S(\lambda)$				$S_{D65\lambda}(\lambda) \cdot V(\lambda)$
	red	yellow	green	blue	
630	13.2919	5.3532	0.0481	0.3358	2.0889
640	9.3843	3.7352	0	0.9695	1.3861
650	6.0698	2.4064	0	2.2454	0.8100
660	3.6464	1.4418	0	1.3599	0.4629
670	2.0058	0.7892	0	0.6308	0.2492
680	1.1149	0.4376	0	1.2166	0.1260
690	0.5590	0.2191	0	1.1493	0.0541
700	0.2902	0.1137	0	0.7120	0.0278
710	0.1533	0.0601	0	0.3918	0.0148
720	0.0742	0.0290	0	0.2055	0.0058
730	0.0386	0.0152	0	0.1049	0.0033
740	0.0232	0.0089	0	0.0516	0.0014
750	0.0077	0.0030	0	0.0254	0.0006
760	0.0045	0.0017	0	0.0129	0.0004
770	0.0022	0.0009	0	0.0065	0
780	0.0010	0.0004	0	0.0033	0
Sum	100	100	100	100	100

Annex E
(normative)
Test of refractive powers

E.1 Spherical and astigmatic refractive powers

E.1.1 Apparatus

E.1.1.1 Telescope

A telescope with an aperture nominally 20 mm and a magnification between 10 and 30, fitted with an adjustable eyepiece incorporating a reticular.

E.1.1.2 Illuminated target

A target, consisting of a black plate incorporating the cut-out pattern shown in Figure E.1, behind which is located a light source of adjustable luminance with a condenser, if necessary, to focus the magnified image of the light source on the telescope objective.

The large annulus of the target has an outer diameter of 23 ± 0.1 mm with an annular aperture of 0.6 ± 0.1 mm. The small annulus has a inner diameter of 11.0 ±0.1 mm with annular aperture of 0.6 ± 0.1 mm. The central aperture has a diameter of 0.6 ± 0.1 mm.

The bars are nominally 20 mm long and 2 mm wide with a nominal 2 mm separation.

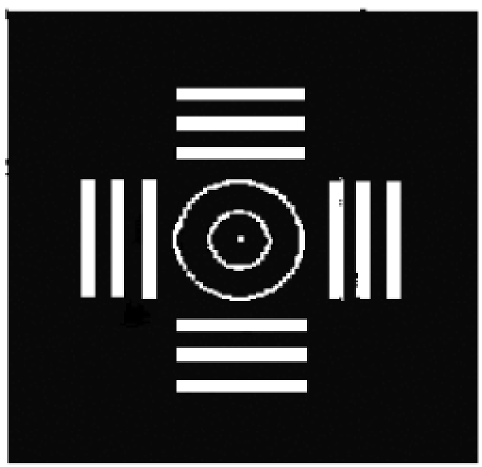


Figure E.1 — Telescopic target

E.1.1.3 Filter

A filter with its maximum transmittance in the green part of the spectrum may be used to reduce chromatic aberrations. τ_r^2

E.1.1.4 Calibration lenses

Lenses with positive and negative spherical refractive powers of 0.06 m^{-1}, 0.12 m^{-1} and 0.25 m^{-1} (tolerance ± 0.01 m^{-1}).

E.1.2 Arrangement and calibration of apparatus

The telescope and illuminated target are placed on the same optical axis 4.60±0.02 m apart.

The observer focuses the reticule and the target and aligns the telescope to obtain a clear image of the pattern. This setting is regarded as the zero point of the focusing scale of the telescope.

The focusing adjustment of the telescope is calibrated with the calibration lenses (E.1.2.4.) so that a power of 0.01 m-1 may be measured. Any other calibration method may be used.

E.1.3 Procedure

The visor is mounted in front of the telescope as worn and measurements shall be taken at the sign points as specified in 4.5.9.2.6

E.1.3.1 Spherical and astigmatic refractive powers

E.1.3.1.1 Visors without astigmatic refractive power

The telescope is adjusted until the image of the target is perfectly resolved.

The spherical power of the visor is then read from the scale of the telescope.

E.1.3.1.2 Visor with astigmatic refractive power

The target, on the visor, is rotated in order to align the principal meridians of the visor with the bars on the target. The telescope is focused firstly on one set of bars (measurement D_1) and then on the perpendicular bars (measurement D_2). The spherical power is the mean, $(D_1 + D_2)/2$, the astigmatic refractive power is the absolute difference, $| D_1 - D_2 |$, of the two measurements.

E.2. Determination of the difference in prismatic refractive power

E.2.1 Apparatus

The arrangement of the reference method is shown in figure E.2.

E.2.2.1 Procedure

The diaphragm LB_1, illuminated by the light source, is adjusted in such a way that it produces an image on the plane B when the visor (P) is not in position. The visor is placed in front of the lens L_2 so that the axis of the visor is parallel to the optical axis of the test assembly.

Adjustable tilt visors are positioned with their ocular regions normal to the optical axis of the equipment.
Measure the vertical and horizontal distance between the two displaced images arising from the two ocular areas of the visor.

These distances in cm are divided by 2 to give the horizontal and vertical prismatic difference in cm/m.

If the light paths which correspond to the two eye regions cross, the prismatic refractive power is "base in" and if the light paths do not cross, it is "base out".

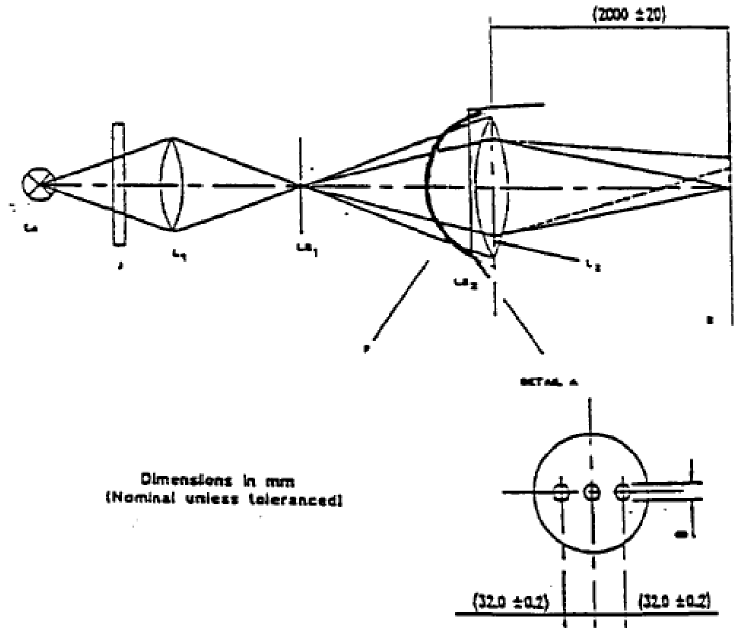


Figure E.2 — Arrangement apparatus for measurement of prismatic difference

L_a = light source, for example, small filaments lamp, laser with wavelength of 600±70 nm, etc.

J = interface filter, with peak transmittance in the green part of the spectrum (required only if a filament lamp is used as the light source).

L_1 = achromatic lens focal length between 20 and 50 mm.

LB1 = diaphragm, diameter of aperture 1 mm nominal

P = visor

LB_2 = diaphragm as shown in detail A

L_2 = achromatic lens, 1,000 mm nominal focal length and 75 mm nominal diameter

B = image plane

Annex F
(normative)
Test for mist-retardance

F.1 Apparatus

Apparatus to determine the change in the non-diffused transmittance value, as shown in Figure F.1.

The nominal diameter of the parallel beam is 10 mm. The size of the beam divider, reflector R and lens L_3 shall be selected in such a way that diffused light is captured up to an angle of 0.75°. If a lens L_3 with a nominal focal length f3 = 400 mm is used, the nominal diameter of a diaphragm is 10 mm. The plane of the diaphragm must lie within the focal plane of the lens L_3.

The following focal lengths f_i of the lens L_i are nominal examples and will not affect the test results:

$$f_1 = 10 \text{ mm and } f_2 = 100 \text{ mm}$$

The light source shall be a laser with a wavelength of 600±70 nm.

The volume of air above the water bath is at least 4 litres. The seating ring has a nominal diameter of 35 mm and a nominal height of 24 mm is then measured to the highest point of the seating ring. A soft rubber ring, 3 mm thick and 3 mm wide (nominal dimensions), is inserted between the sample and the seating ring.

The water bath container also contains a ventilator to circulate the air. In addition, there must also be a device to stabilise the temperature on the water bath.

F.2 Samples

At least 3 samples of the same type are to be tested. Before the test, the samples are conditioned for one hour in distilled water (at least 5 cm^3 water per cm^2 sample surface area) at 23 ±5 °C, then dabbed dry and then conditioned in air for at least 12 hours at 23 ± 5 °C and 50 per cent nominal relative humidity.

F.3 Procedure and evaluation

The ambient temperature during the measurement is 23 ± 5 °C.

The temperature of the water bath is set at 50 ±0.5 °C. The air above the water bath is circulated usi ng a ventilator, so that it becomes saturated with water vapour. During this time, the measurement opening is to be covered. The ventilator is switched off before the measurement.

To measure the change in the value of the transmittance τ_r the sample is placed on the seating ring and the time determined until the square of τ_r has dropped to less than 80 per cent of the initial value of the sample without fogging (time without fogging).

$$\tau_r^2 = \frac{\Phi b}{\Phi u}$$

Where

Φb is the luminous flux when there is fogging on the sample

Φu is the luminous flux before fogging

Initial fogging of maximum 0.5 s duration shall not be taken into consideration in the evaluation.

NOTE 1 Since the light beam passes through the samples twice, this measurement defines, τ_r^2
.

NOTE 2 The period until the start of the fogging can usually be determined visually. However, with some types of coating the formulation of the surface water causes diffusion to increase more slowly so that visual evaluation is difficult. The detection apparatus described in F.1.1 should then be used.

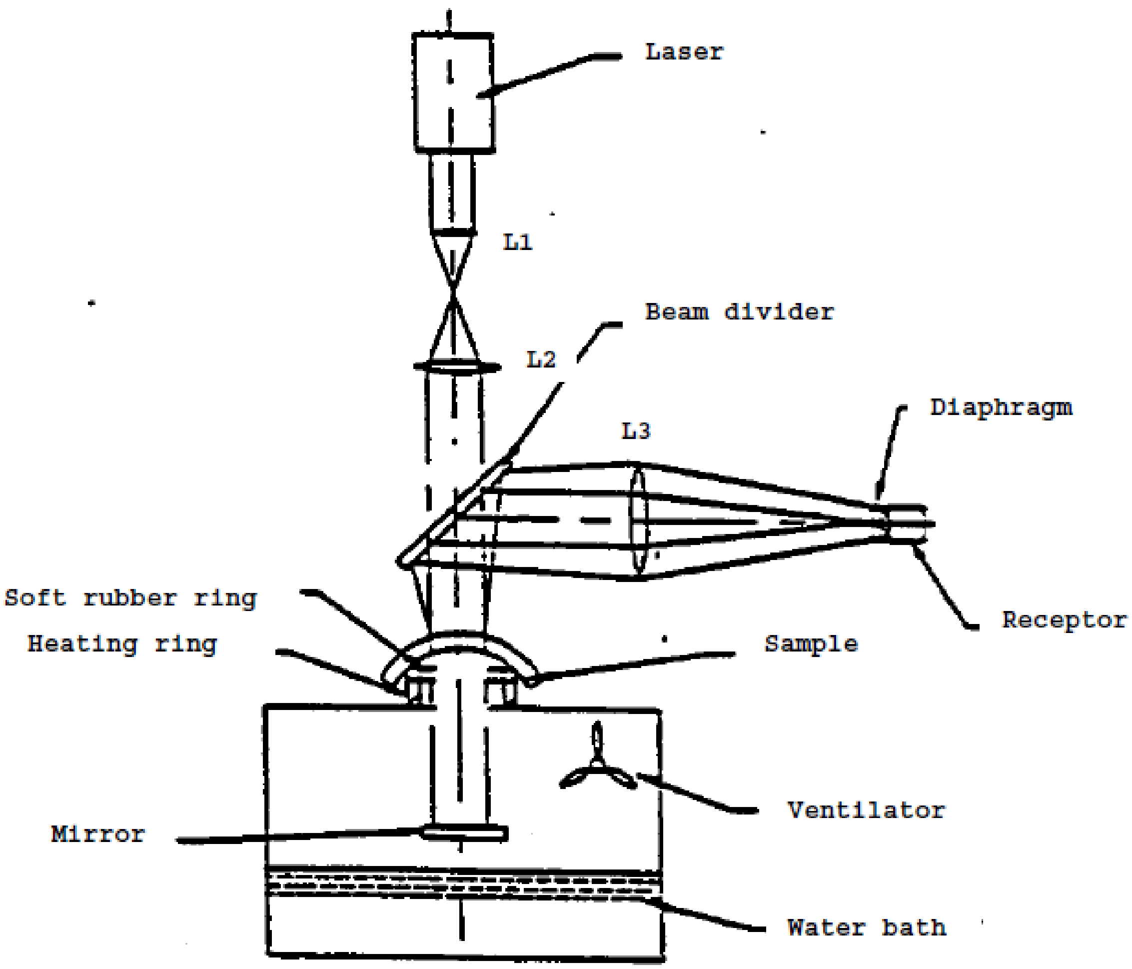


Figure F.1 — Test apparatus for mist-retardant visor